REVISIONS

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DRAWN BY	DATE	CHECKED BY	DATE
E. Koschmann	211028		
REVIEWED BY	DATE	REVIEWED BY	DATE
LEAD APPROVAL	DATE	FINAL APPROVAL	DATE
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TOLERANCES

DECIMAL
.XX = N/A
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TITLE

MANUAL,OPERATOR'S,PFCC 5727A

SCALE	SIZE	FSCM	SHEET	DRAWING NUMBER	REV.
N / A	A	61651	1 OF 24	20-001	C

OPERATING MANUAL
FOR
MODEL 5727A

CAPACITOR CHARGING POWER SUPPLY

Analog Modules, Inc.
126 Baywood Avenue
Longwood, FL 32750
Ph:(407) 339-4355

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MODEL 5727A

SPECIAL PRECAUTIONS

CAUTION

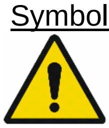
- Read this manual carefully before attempting to install or operate the model 5727A.
- This unit contains no user serviceable parts. Manufacturer's warranty is void if field serviced.
- Proper installation in the OEM system is necessary to limit access to lethal voltages.
- The OEM system design using this power supply must provide adequate protection for the system operator from the high voltage output and also to prevent adverse events to the operator or patient due to electromagnetic disturbances.
- Caution: Use with other cables and accessories may negatively affect EMC performance. OEM users should verify proper EMC performance in their system.

LABELS

<u>Abbreviations:</u>

A	amperes
AC	alternating current
°C	degrees Celsius
CW	Continuous wave
Hz	hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kW	kilowatts
kΩ	kiloohms
(L)	line conductor, single phase system
mA	milliamp
mm	millimeter
mV	millivolt
(N)	neutral conductor, single phase system
V	volts
VAC	alternating voltage
VDC	direct voltage
W/°C	watts per degree Celsius
Z	impedance
OEM	original equipment manufacturer
PFN	pulse forming network
W	watts
pk	peak
HV	high voltage
RTN	return
N/C	no connection
f/s	full scale
Ω	ohms

<u>Symbols:</u>



Hazard: This equipment produces high voltages which can be fatal. Only Analog Modules, Inc. qualified technicians are allowed to service this equipment.

High Voltage Present. This equipment produces high voltages which can be fatal. Only qualified service personnel are permitted to install this power supply. Please see manual.

Chassis Ground: This symbol indicates where the protective earth ground connection is located.

SECTION 1

INTRODUCTION

1 INTRODUCTION

The 5727A series switch-mode power modules use proprietary power conversion techniques to provide the highest power density of any power module currently on the market. All models are designed to meet the isolation and leakage current requirements for IEC 60601-1 3rd edition.

All supplies feature open circuit, short circuit, and thermal overload protection, as well as active power factor correction.

The Model 5727A is a capacitor-charging module designed to a) repeatedly charge energy storage capacitors for pulsed power applications or b) charge energy storage capacitors to a specified voltage and to maintain this output level for switched variable pulse width load applications.

SECTION 2

ENVIRONMENTAL DATA

2 ENVIRONMENTAL DATA

2.1 Operating

Ambient Temperature:	0°C to +40°C
Altitude:	up to 2000 m

2.2 Non-operating (transport and storage)

Ambient Temperature:	-40°C to +70°C
Relative Humidity:	10% to 100%, non-condensing
Atmospheric Pressure:	500 hPa to 1060 hPa (7.25 to 15.37 psia)

2.3 Environmental Risk

The substances used in the product pose no known health or environmental risk associated with the disposal of the product at the end of their useful lives.

This equipment is designed for industrial, hospital, and healthcare facilities. It is not designed for residential usage.

2.4 Regulatory:

Leakage current:	<400 µA
Isolation	1500 VAC, 1MOOP
EMI:	EN55011 Class A with Optional Filter
Immunity:	IEC 60601-1-2 Ed 4.0
Safety:	IEC/EN 60601 3rd edition
Industrial	IEC 61010-1:2010
RoHS	DIRECTIVE EU 2015/863 (RoHS 3)
MTBF	170,000 hours

This power supply's secondary circuits are designed for one Means of Operator Protection (1 MOOP) clearance distances up to 4 kV output. The OEM system designer must take that into consideration when designing the OEM system MOOP between an operator interface and the high voltage output and power supply controls. A recommended practice is to provide isolated signals between the OEM system computer and the power supply control inputs.

SECTION 3

SET-UP AND INTERFACE

3 SET-UP AND INTERFACE

3.1 Mechanical Considerations

Installation begins with mounting the module in a suitable enclosure. Follow the criteria below:

A. Enclosure must provide protection against possible human contact with live parts.

B. Enclosure must be adequately grounded to protective earth to ensure operator safety or constructed entirely of a non-conductive material. In the latter case, all internal exposed metal parts must be grounded to protective earth.

C. A clearance of 2" should be maintained on the air input and output sides to facilitate proper air flow.

D. Mounting screws may extend 1/8" max. into the module.

E. See Section 6 for suggested mounting plate dimensions.

F. If units are operated in parallel, the units can be stacked, but must adhere to the above restrictions.

3.2 Electrical Connections

Electrical connections are made in three groups: the power input, HV output, and control interface groups. These groups are terminated in three different connectors.

3.2.1 Power Input Group

The AC power-input connector is a Phoenix Contact 1017503 terminal block or similar. Use at least #14 AWG wires for L1, L2 and protective earth connections. Protective earth connection is a 10-32 GND stud on the outside of the chassis.

L1 and L2 inputs can be put in either terminal block position. Both L1 and L2 are fused within the power module with a non-user replaceable fuse.

The unit contains an active power factor correction circuit that accepts a wide range of input voltages.

100 – 130 VAC 50/60 Hz, 15.6 A @ 100 VAC, 1300 W output, full discharge

200 – 240 VAC 50/60 Hz, 12.0 A @ 200 VAC, 2000 W output, partial discharge

3.2.2 HV Output Group

The HV output connector (up to 4 kV) is a TE Connectivity 770339-1. The mating connector is a Molex 19-09-2032 with Molex 02-09-2103 male pins. The HV output cable is supplied as an AMI 4695 assembly.

The HV output Red / Pin 3 must connect to the load capacitor bank. The HV RTN Blk / Pin1 must connect to the load capacitor bank and flashlamp return star ground. Whether the unit is configured as a negative output or positive output, the black wire is always tied the chassis return.

The output can be configured from 400 V to 4 kV. Efficiency is typically 85 to 90% when fully loaded.

Typical charge rate or ramp output power for the module is 1300 J/s for full discharge applications and 2000 J/s for partial discharge applications. Power output will decline for any charger that is operated below 80% of its full output voltage. Please refer to the Power Derating Curve in Section 6 for the reduction of output power with reduced output voltage.

There are other factors that cause a reduction of output power such as the AC Mains service rating, type of load discharge, and the output voltage range. Please refer to the output power tables below for the maximum output power achievable according to the input AC Mains.

Table 1, Maximum Load Power, Full Discharge*, 1250 to 4000 VDC Output

AC Mains (VAC)	Mains Service Limit (Amps)	Output Voltage Range	Maximum Load Power (Watts)
100 to 120	15	1250 to 2000	900 (with EMI filter)
100 to 120	15	>2000 to 4000	800 (with EMI filter)
100 to 120	20	1250 to 4000	1000 (no EMI filter)
200 to 240	15	1250 to 4000	1500

*Full Discharge loads where >99% of the capacitor energy is released into the load.

Table 2, Maximum Load Power, Partial Discharge*, 400 to 1600 VDC Output

AC Mains (VAC)	Mains Circuit Breaker (Amps)	Output Voltage Range	Maximum Load Power (Watts)
100 to 120	15	400 to 1600	1000 (with EMI filter)
100 to 120	20	400 to 1600	1300 (no EMI filter)
200 to 240	15	400 to 1600	2000

*Partial Discharge loads where ≤50% of the capacitor energy is released into the load.

3.2.3 Control Interface Group

The Control Interface connector is a standard 15-pin D-sub connector. The part number is SPC15281.

The reference figures for each signal are schematic representations of the interface and may be found on the 5727A Interface Circuits pages.

The following connections are available from the DB15 Interface:

Table 3, Control Interface Signals

PIN	Signal Name	Description
1	ENABLE	3.5 to 10 V input to enable charger. 10 kΩ load impedance (reference Figure 1).
2	N/C RESERVED	NO CONNECTION.
3	OVERTEMP STATUS IND	Internal 10 kΩ resistor to +12 V. FET output rated at 50 V, 200 mA. Fault indicated by low condition (reference Figure 2). This is a warning indicator only.
4	PROGRAM RTN / GND	Differential input return for program voltage. Connect to signal return for single ended operation. (reference Figure 3).
5	PROGRAM VOLTAGE	0 to 10 V control differential input for 0 to 100% rated output voltage (reference Figure 3).
6	OVERVOLTAGE STATUS IND	Internal 10 kΩ resistor to +12 V. FET output rated at 50 V, 200 mA. If OVP set voltage is exceeded a fault will be indicated by a low signal at this pin. The charger will also be inhibited to prevent it from exceeding this voltage. (reference Figure 4).
7	VOUT PEAK HOLD	Output monitors output voltage with a peak-hold circuit. 0 to 10 V represents 0 to 100% rated output voltage. To ensure good stability, the time constant of this circuit is ≈ 2 min. This should be considered when lowering the operating voltage from a higher value. For a direct reading of the output voltage, pin 8 can be monitored (reference Figure 5).
8	VOUT MONITOR	Output which directly monitors output voltage. 0 to 10 V represents 0 to 100% rated output voltage (reference Figure 6).
9	+12VDC	12 V output capable of delivering 100 mA (reference Figure 7).
10	N/C RESERVED	NO CONNECTION.
11	+10V REFERENCE	10 V output capable of delivering 2 mA (reference Figure 8).
12	SIGNAL RETURN	Signal return for any external control circuitry. Common to pin 14.

13	END OF CHARGE IND	Internal 10 kΩ resistor to +12 V. FET output rated at 50 V, 200 mA. When PFN is charged to programmed voltage, the output is pulled low (reference Figure 9).
14	SIGNAL RETURN	Signal return for any external control circuitry. Common to pin 12.
15	GROUND INTERLOCK	Must be connected to signal return pin or charger will remain inhibited (reference Figure 10).

5727A INTERFACE CIRCUITS

Figure 1, Enable

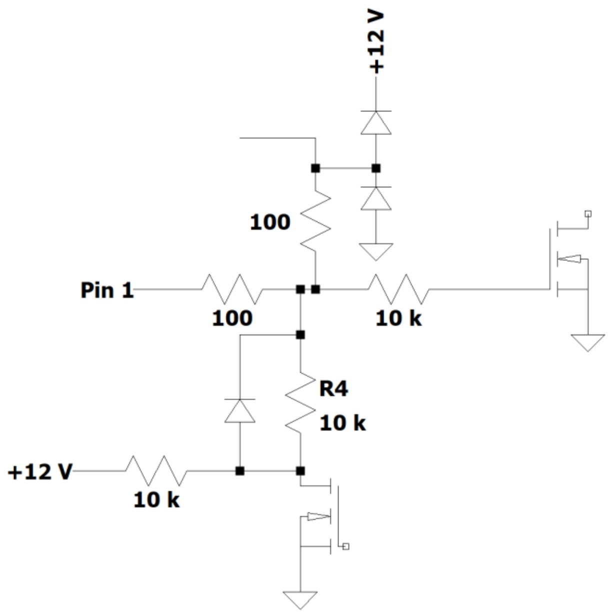


Figure 2, Over Temp Status

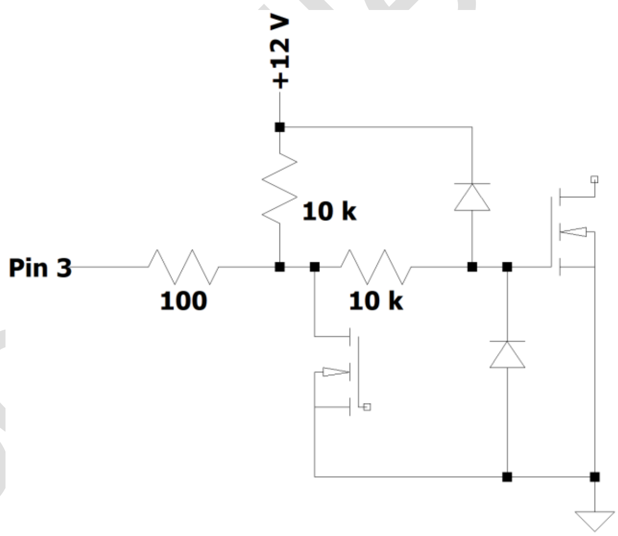


Figure 3, PROGRAM VOLTAGE

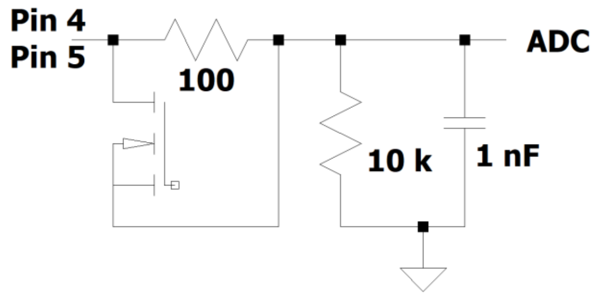


Figure 4, OVER VOLTAGE STATUS

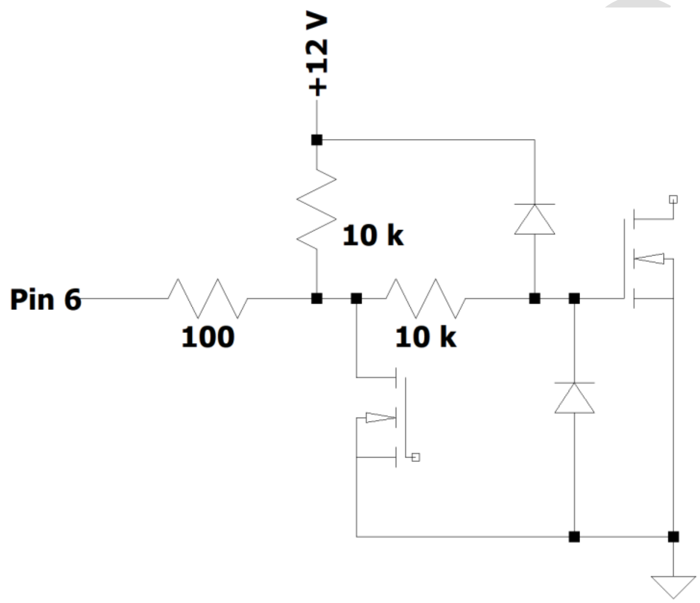


Figure 5, VOLTAGE PEAK HOLD

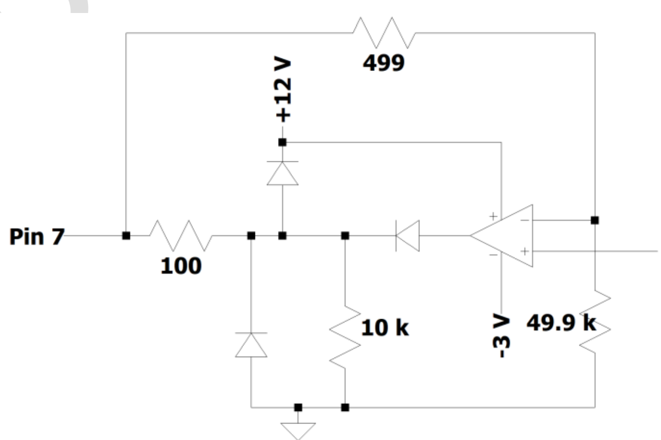


Figure 6, VOLTAGE MONITOR

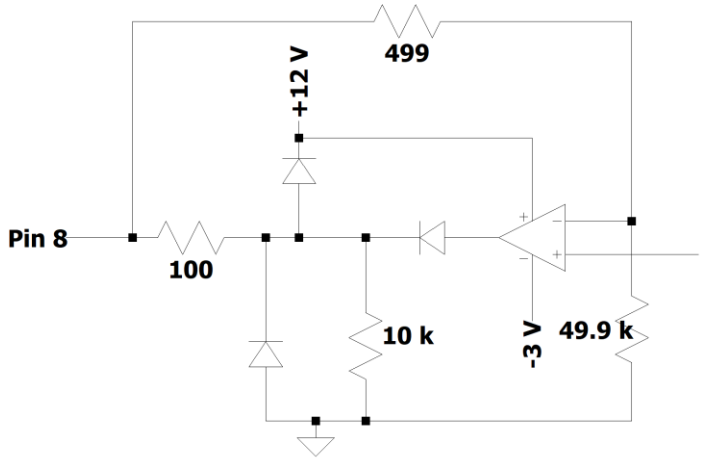


Figure 7, +12 VDC

Figure 8, +10VDC REFERENCE

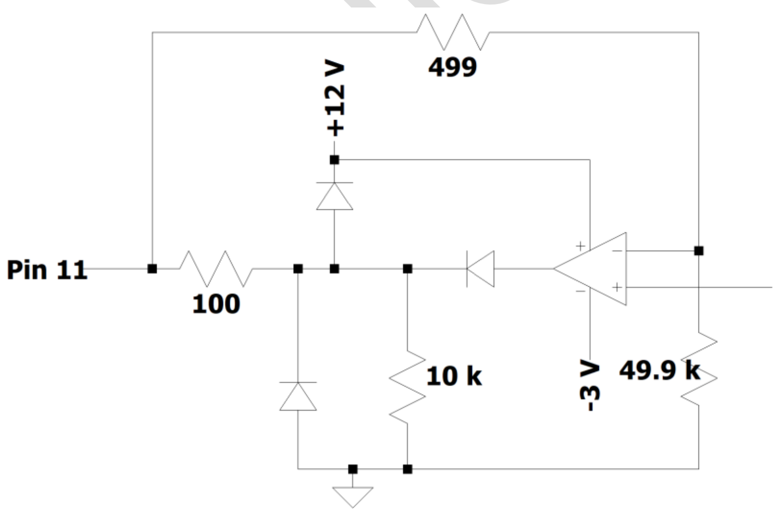


Figure 9, END OF CHARGE

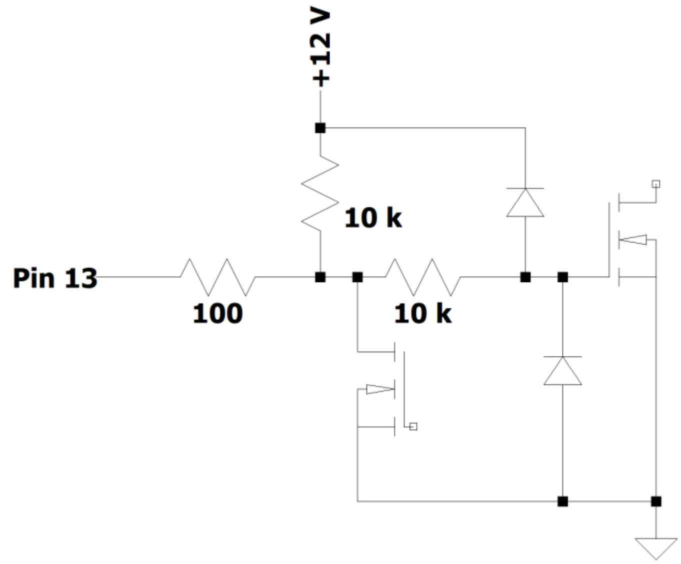
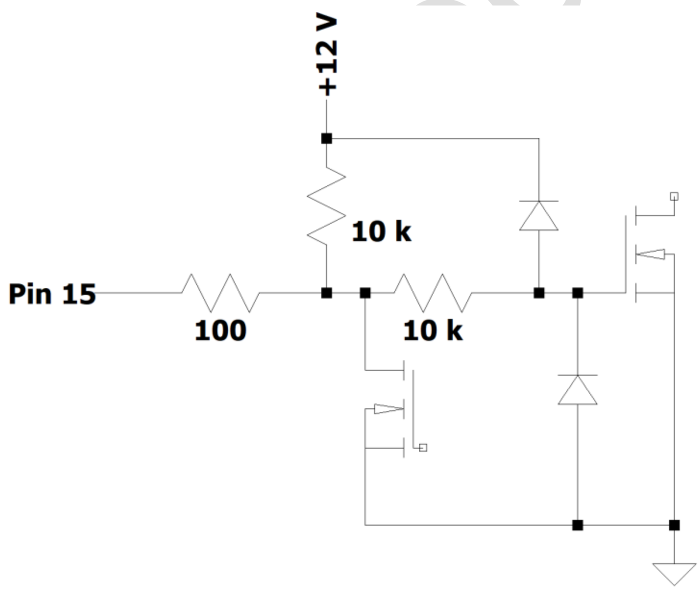


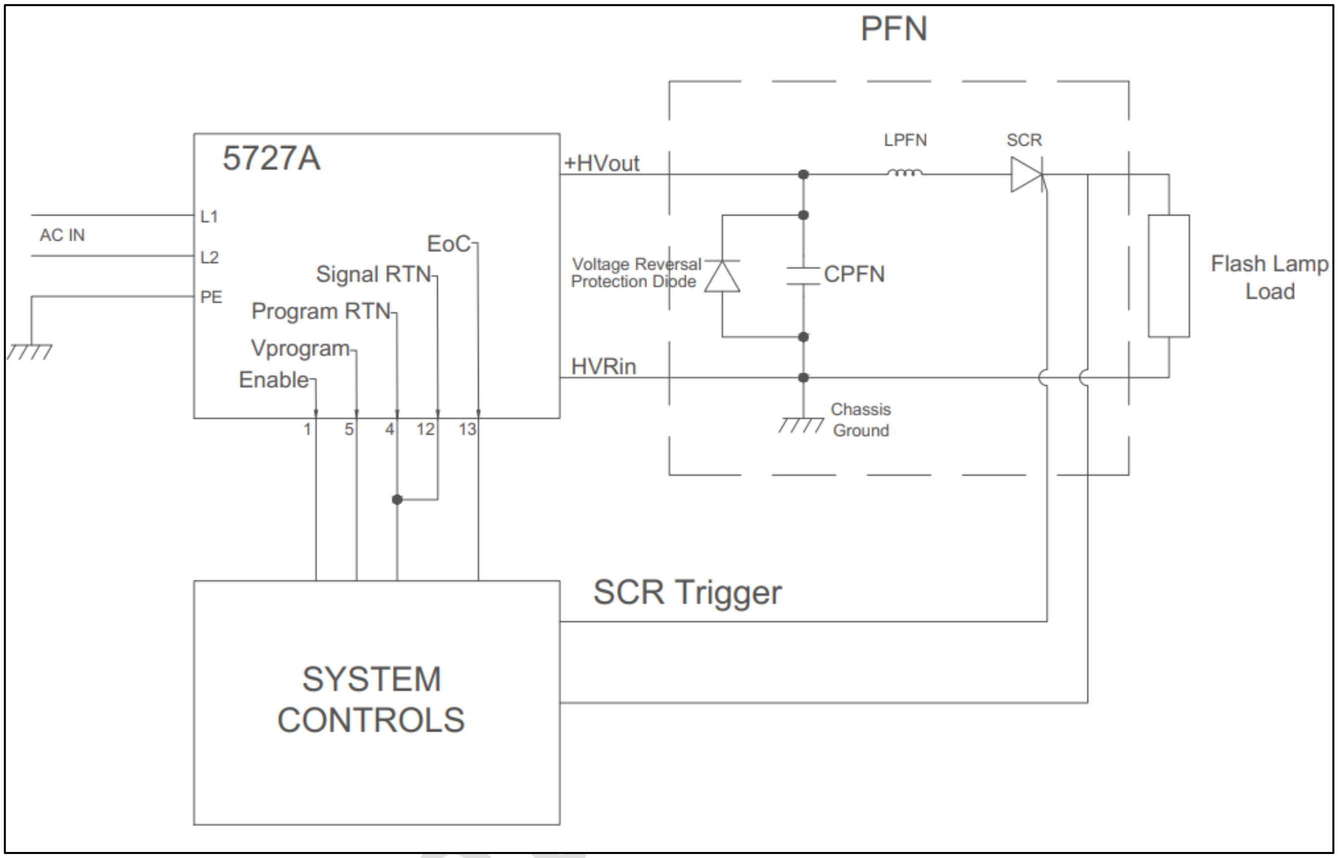
Figure 10, GND INTERLOCK



3.3 Typical Applications

3.3.1 Using the Model 5727A with a pulse forming network (PFN), full discharge load.

Figure 11, Pulse Forming Network Application



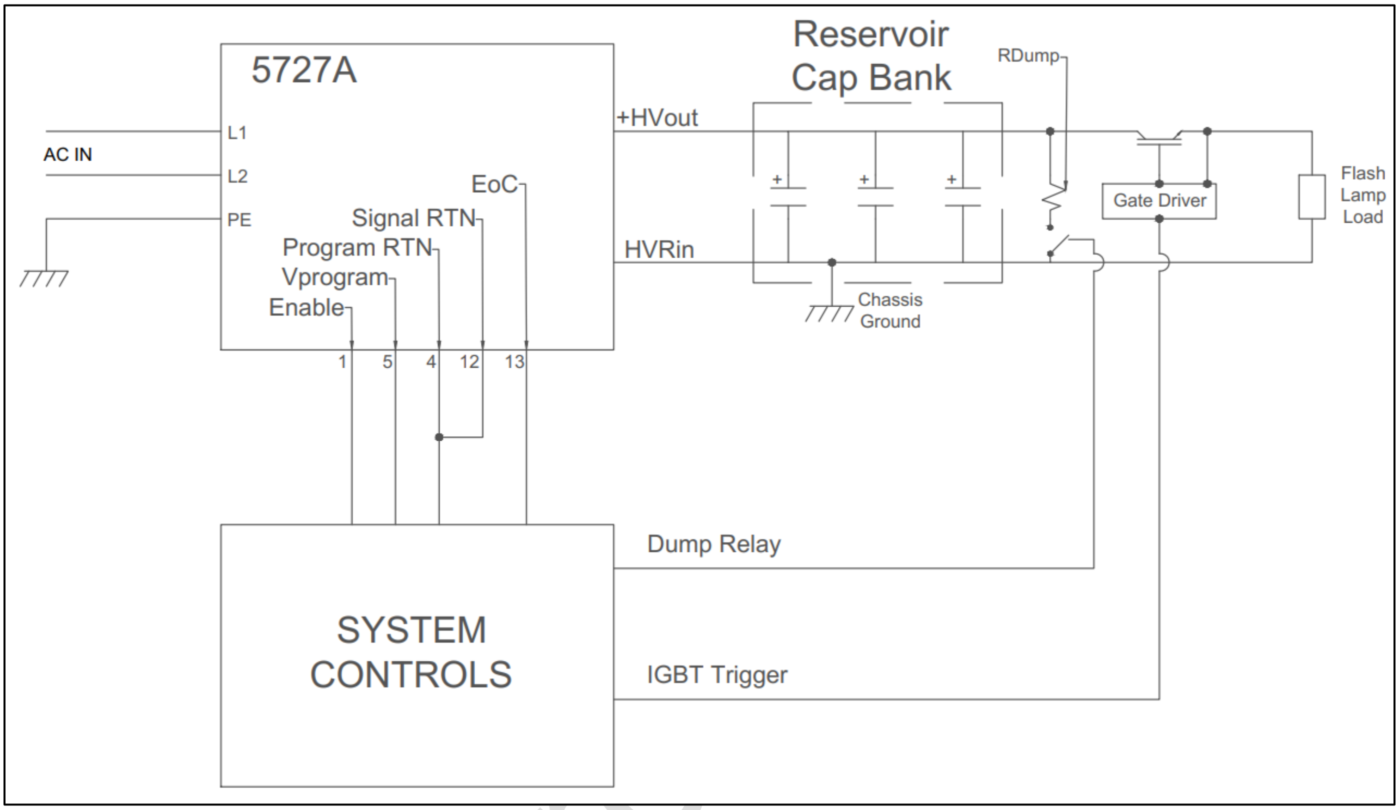
The above block diagram shows a typical connection to and from the Model 5727A capacitor charging power supply and a properly damped pulse forming network (PFN). In PFN operation, when the 5727A is ENABLED using pin 1 (see section 3.2.3 Control Interface Group for control interface description), the supply will charge up the PFN capacitor to the programmed value on pins 4 and 5, then the END OF CHARGE signal on pin 13 will go low.

Before discharging the PFN into the load, such as a flashlamp, the Model 5727A should be disabled by pulling the ENABLE pin low. After the PFN capacitor has discharged and the SCR has commutated, the charging cycle can be enabled again using the ENABLE input.

PFN circuit designers may choose to include a limiting resistor and a reversal protection diode to protect the power supply if there is any possibility of an arc in the PFN circuitry or improper PFN damping.

3.3.2 Using the Model 5727A with a partial discharge network

Figure 13, Partial Discharge Network Application



In this application, the 5727A is ENABLED using pin 1 (see section 3.2.3 Control Interface Group for control interface description), the supply will charge up the capacitor bank to the programmed value on pins 4 and 5, then the END OF CHARGE (EOC) signal on pin 13 will go low. Once EOC goes low, the IGBT can be turned on to deliver short, high current pulses to the load, usually a flashlamp. The IGBT will be turned off at the end of the discharge pulse, but the capacitor will still be charged, albeit at a lower voltage, since a fraction of the stored energy has been used. The power supply does not need to be inhibited during this process and will continuously recharge the capacitor bank. As soon as the capacitor bank charge returns to the programmed value EOC will go low and the IGBT can be trigger again to deliver high current pulses into the load.

This mode of operation can also be referred to as Reservoir Charging.

3.3.3 Parallel Operation Set Up

Operating the Model 5727A power supply in parallel is very simple and does not require a special interfacing cable. The 5727A interface circuits are designed to connect directly to another 5727A power supply without added circuitry or cutting wires to isolate each other. Therefore the 15-pin interface can use a single ribbon cable with two or more 15-pin D plug connectors for each power supply. The only requirement is that the units in parallel must be of the same output voltage; for example, two 5727A-500 will work in parallel. This allows each power supply to charge the load capacitor in parallel and will share the required charging power.

Referring to section 3.2.4, the system controller needs to source enough current for the enable input for the number of paralleled units with each 10 kΩ input impedance. The same is required for the program voltage input which has 10 kΩ input impedance; therefore, the analog signal source needs to be sufficient for the number of parallel units. For example, to parallel two units the program voltage input current at maximum 10 Volts will be 10 V/5 kΩ = 2 mA of source current capacity, and for three units in parallel will be 3.3 mA.

When the capacitor has reached full charge voltage, End of Charge output on pin 13 will go low to indicate to the system controller the power supplies have stopped charging. Since this output is pulled low by a FET with an internal 10 kΩ pull-up resistor there is no need to isolate this signal between the parallel units (see Table 3 for signal descriptions). The Overvoltage Status output on pin 6 (see section 3.2.4 Figure 4) is the power supply's fault status output and also an input signal. If any of the power supplies has a fault this signal is pulled low and the other power supplies will detect the fault condition and also shut down. Therefore, any fault such as overvoltage, no load dV/dt, or a PFC error will shut down all the power supplies until the fault is corrected.

SECTION 4

OPERATION

4 OPERATION

4.1 Power Up Sequence

Care must be exercised in the power up sequence. This is especially true with a microprocessor-controlled system. The proper power up sequence is as follows:

Before applying AC to the power module,

- Enable should be low.
- Program voltage should be 0 V.
- Once these conditions are true, the AC mains power input may be applied.

4.2 Power Down Sequence

Before removing AC from the module,

- Enable should be pulled low.
- Program voltage should be set to 0 V.
- The AC mains power may then be removed.

4.3 Cooling

The power module has an internal DC fan for forced air cooling. A clearance of 2” should be maintained on the air input and output sides to facilitate proper air flow. See outline drawing for airflow direction.

4.4 Electromagnetic Compatibility and Interference (EMC/EMI)

The Model 5727A capacitor charging power supply has been tested to pass EMC requirements for medical devices. Since the power supply composes only one part of an OEM medical device, the system EMC compliance must be verified by the OEM system designer. OEM system design should use a shielded control cable and may need ferrite noise suppressors on the AC input and high voltage output wires for the final system EMC compliance.

The EMISSIONS characteristics of this equipment make it suitable for use in industrial areas and hospitals (CISPR 11 class A). It is not designed for residential usage. If it is used in a residential environment (for which CISPR 11 class B is normally required) this equipment might not offer adequate protection to radio-frequency communication services. The OEM system designer might need to take mitigation measures, such as relocating or re-orienting the equipment.

The power supply has been tested to function properly in proximity to portable RF communication equipment no closer than 30 cm (12 inches) to any part of the power supply, including the cables specified in this manual. The power supply was tested under the following immunity (EMC) frequency conditions:

Radiated RF-EM fields 80 MHz to 2.7 GHz @ 80 % AM at 1 kHz

Radiated proximity fields from RF wireless communications equipment at 2.45 GHz

Conducted induced by RF Fields, 0.15 MHz – 80 MHz and ISM bands between 0.15 MHz and 80 MHz at 80 % AM at 1 kHz.

Normally the supply will continue to operate per specifications, however an EMI condition could cause an internal fault where the power supply shuts down. If such a condition occurs the power supply will need to be re-enabled. This may require the enable input signal to be toggled to OFF and then ON, or the AC power may need to be switched off and on to reset the fault.

Risk Management due to EMC needs to be evaluated by the OEM system designer regarding the OEM system's EMC risk analysis (FMEA). Since the power supply is a component of the system the risk management cannot be evaluated at this component level. The OEM system engineer should contact Analog Modules engineering for support in preparing their system level risk management process.

SECTION 5

MAINTENANCE

5 MAINTENANCE

No maintenance is required.

CAUTION

To prevent electric shock, do not remove screws. There are no user serviceable parts inside. Refer all servicing to factory qualified service personnel.

SECTION 6

DOCUMENTATION

6 DOCUMENTATION

Figure 15, Power Derating Curve

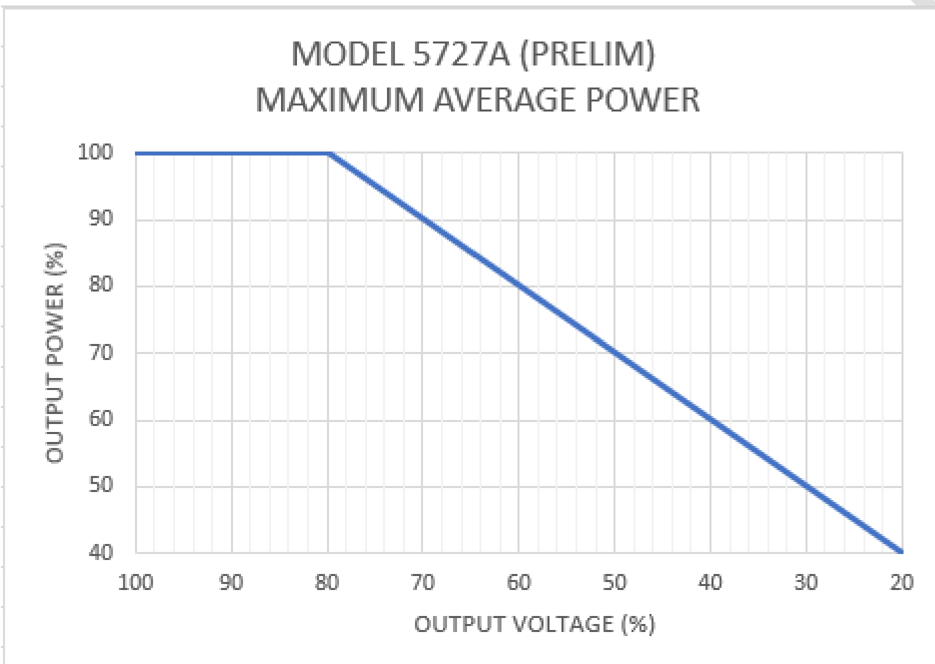


Figure 16, Mounting Plate

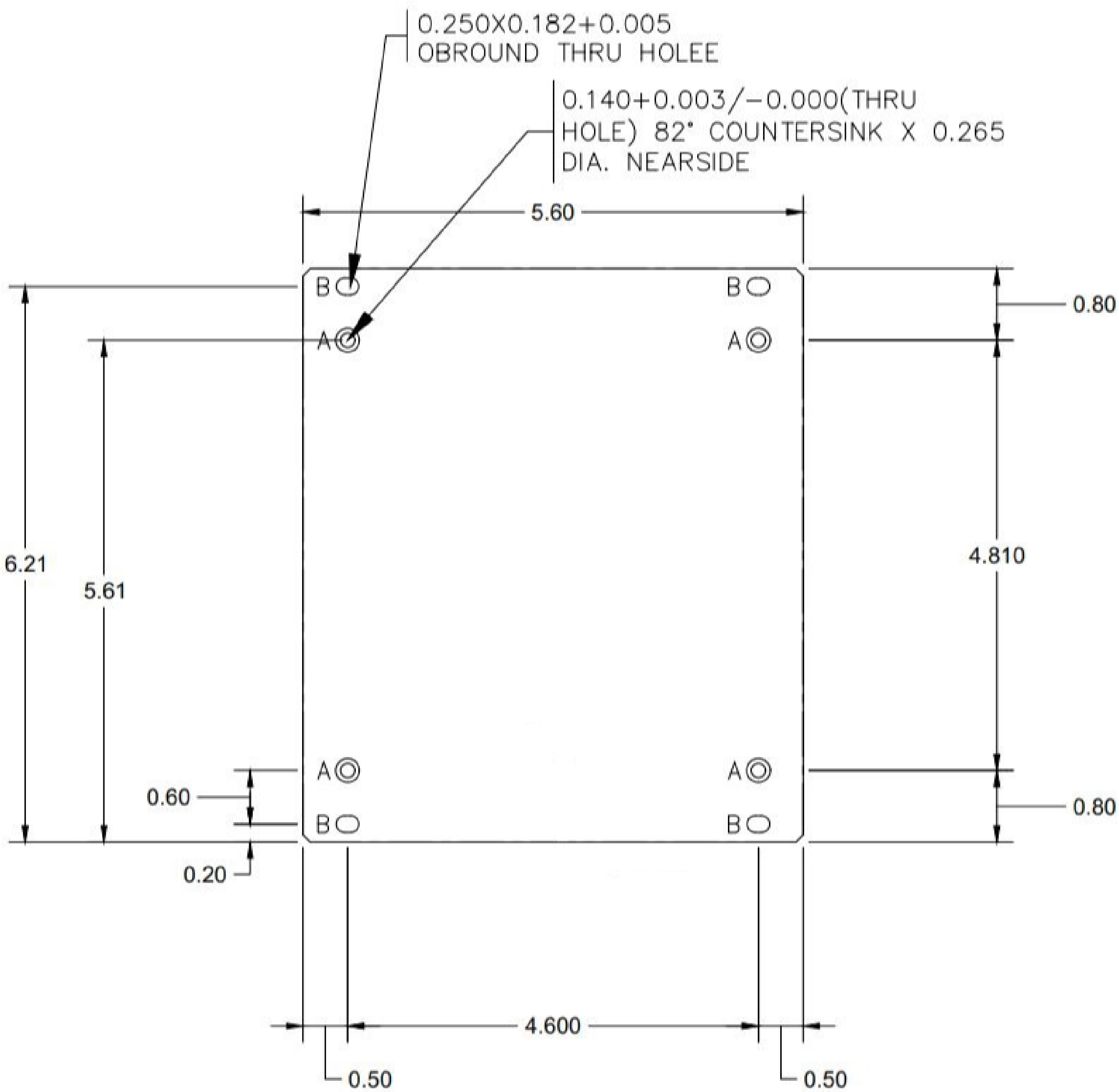


Figure 17, Outline Drawing